MONITORING ENVIRONMENTAL LEVELS OF METHYL BROMIDE DURING COMMODITY FUMIGATIONS

by

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SUMMARY

Area measurements of methyl bromide levels were made in the vicinity of three standing commodity fumigation chambers. The results from these measurements indicate that employees working within 25 feet of the chambers studied during venting and door opening operations should undergo personal monitoring to accurately assess methyl bromide exposure. Methyl bromide levels in work areas located 50 feet or more from the chamber were 1.0 ppm or below.

INTRODUCTION

Commodity fumigations using methyl bromide were examined in San Mateo, Stanislaus, and Yolo Counties. The operation in San Mateo County was a small chamber used by a candy processor to fumigate packaged nuts. The operations in Stanislaus and Yolo Counties were walnut processors, fumigating nuts in chambers or holding tanks, prior to sorting, grading, and packing.

Fumigations generally involve three separate operations: injection, venting (aeration), and door opening to unload commodities. Injections were performed by certified applicators through closed systems. After injection, the commodities are fumigated for 12 hours (overnight). Venting takes place by opening an exhaust stack and an air inlet vent and operating the circulating fans. A chamber is commonly vented from one to several hours. Chamber doors are opened immediately following venting. Usually, one to three people perform the mechanics of these operations, with each operation requiring one to three minutes. Commodities are unloaded by forklift, handtruck, or conveyor belt (depending upon chamber size and configuration), at varying intervals after the doors are opened, depending upon the work rate at the site.

MATERIALS AND METHODS

Grab samples were collected with charcoal adsorbent tubes affixed to MSA Model S portable air pumps, Drager colorimetric detector tubes, and a portable infrared analyzer (MIRAN). Area samples were collected rather than personal samples to represent potentially "worst case" situations because workers are usually not present in the high exposure areas for the minimum 10-minute monitoring period. A few employees working around the fumigation chambers consented to be subjects for personal monitoring.

Sampling and analytical procedures were adaptations of NIOSH methods with refinements made by the California Department of Food and Agriculture's (CDFA's) Chemistry Laboratory Services, providing detection limits down to 15 ppb by electron-capture gas chromatography (1, 2). Air pumps were calibrated at 100 or 300 ml/min. by bubble tube or Kurz 540S flow indicator.

Sampling locations were selected following walk-through evaluations of each fumigation site. Samples were collected from three different zones: (1) as close to the source of methyl bromide emissions as feasible; (2) other locations within the processing facility near workers; (3) personal samples from cooperative workers at the facilities. The area samples were collected at ground level, underlying the "worst case" approach, since methyl bromide is heavier than air and can be expected to be found in higher concentrations closer to the ground.

RESULTS

Environmental levels of methyl bromide measured with charcoal tube sampling for the three facilities monitored are summarized in Tables One through Five. Instantaneous readings from the MIRAN during venting and opening indicate that a plume of methyl bromide is emitted during both operations.

Appreciably high concentrations of methyl bromide may be found in this plume, requiring approximately one minute to dissipate to permissable exposure levels. Samples collected using charcoal tubes for 10 to 30 minutes in the immediate vicinity of a chamber (within 25 feet), during venting and door opening operations, showed levels of 4 to 11 ppm. Area sampling indicated that methyl bromide levels were below 1.0 ppm in work areas located away from the chambers (50 feet or greater) during all phases of the fumigation, including venting and unloading of chamber.

DISCUSSION

This limited survey of methyl bromide use on commodities indicates that large variations can exist in fumigation worker exposure. Exposures will fluctuate depending upon numerous factors: chamber size, ease of door opening operations, number of fumigations performed each week, ventilation time allowed, dosage of methyl bromide used, and time spent performing fumigation activities. A majority of the methyl bromide measurements in the vicinity of the chambers were below 15 ppm (Cal-OSHA permissable exposure level averaged over an eight-hour workday). One measurement, collected September 14, 1982, was over three times the ceiling standard (50 ppm). This, however, was attributed to inadequate venting and occurred during a certification trial for USDA quarantine requirements, with no commodity in the chamber to absorb the methyl bromide. With normal chamber operation, this high level would not be expected to occur.

The investigators had difficulty in developing a sampling strategy for measuring exposure of employees performing fumigation operations of short duration several times daily. The alternative strategy selected was to monitor methyl bromide levels in the vicinity of chambers to determine if environmental levels detectd were high enough to warrant the monitoring of employees working close to the chambers. Since fumigations comprise only a portion of activities at a processing plant, area measurements were made at work stations elsewhere in the plant to determine if chamber operations pose a hazard to employees not involved with the fumigation operation.

Several studies monitoring occupational exposure to airborne contaminants have shown area measurements to be inaccurate for measuring actual worker exposure. Linch and co-workers have compared fixed-station (area) monitors to personal samples in sampling for tetraalkyl lead and carbon monoxide. In neither case did they find correlation between the area and personal monitors (3, 4). Numerous articles summarized by Leidel, et al., confirm the inability of area monitoring for determining personal exposure (5). This view is expressed succinctly by Linch, "only by personal monitoring could a true exposure be determined," (3). It is difficult to generalize worker exposure in any given facility using methyl bromide, except that the employees can be roughly grouped into those directly involved in the fumigations and those not involved. Mitigating hazards to employees involved with the fumigations (the high-risk group) might require the wearing of respiratory protection during venting or door opening operations, increasing the ventilation rate, increasing the duration of ventilation, or a combination of these methods.

Substantial variety exists between fumigation practices at different commodity processing facilities. Measuring exposure hazards, and developing mitigation measures for these hazards, need to be approached on a case-by-case basis. With few exceptions, the firms studied would not have great difficulty in complying with the Cal-OSHA PEL of 15 ppm, eight-hour TWA. Employees involved with fumigation operations should be individually monitored to determine if their exposures exceed excursion or ceiling standards (Cal-OSHA excursion: 25 ppm, five minutes per eight hours; ceiling: 50 ppm, instantaneously), with sampling periods confined to occasions when fumigation operations are being performed.

CONCLUSIONS

1. Methyl bromide levels emitted from fumigation chambers were routinely below 1.0 ppm at 50 feet or more from the chambers monitored. Hence, they would not appear to present a hazard to employees not involved with fumigation operations.

2. Employees directly involved with fumigation operations should be monitored with personal samplers, while performing these tasks to determine if they are being overexposed.

3. Employee exposures in fumigation facilities can be expected to be highly variable, and should be evaluated on a case-by-case basis.

Methyl Bromide Levels Detected by Charcoal Tube Samples

TABLE I

Facility #1, San Mateo County, August 4, 1982

Sample Source	Sampling Time (Minutes)	Methyl Bromide Detected (ppm)
Inside chamber after 3 hrs. venting	15	6.1
Inside chamber after 5 hrs. venting	28 27	0.7 1.0
20 ft. from chamber door, following 5 hrs. venting	23 27	ND* ND
50 ft. from chamber door, following 5 hrs. venting	25 24	ND ND
200 ft. from chamber door, following 5 hrs. venting	22 25	ND 0.1

*ND means none detected at a minimum detectable level of 0.015 ppm.

TABLE II

Facility #2, Yolo County, September 14 1982

Sample Source	Sampling Time (Minutes)	Methyl Bromide Detected (ppm)
Fumigator personnel sample, during injection	23	3.2
Outside of chamber door, during injection	25	14.3
20 ft. from chamber, following door, during injection	50	4.2
40 ft. from chamber, following 30 min. venting	29	2.5
30 ft. from chamber, following 30 min. venting	33 24	0.08 14.7
150 ft. from chamber, following 30 min venting	30	ND
Next to chamber door, moment of opening	23	158.8

TABLE III

Facility #2, Yolo County, September 23, 1982

Sample Source	Sampling Time (Minutes)	Methyl Bromide Detected (ppm)
Fumigator personal sample, during injection	11	0.7
Fumigator personal sample, during injection	3	0.2
Next to chamber door, during injection	31	0.2
Employee personal sample, 60 ft. from chamber, during fumigation	30 29	1.3 ND
60 ft. from chamber, ground level, during fumigation	33	7.0
Employee personal sample, during chamber door opening*	20 20	3.3 5.7

*Sampling time included other duties performed by these employees. Door opening required approximately five minutes.

TABLE IV

Facility #2, Yolo County, September 29, 1983

Sample Source	Sampling Time (Minutes)	Methyl Bromide Detected (ppm)
In front of chamber door, during injection and fumigation	17 15 15	0.3 1.4 0.3
50 ft. from chamber, during injection and fumigation	16	ND
In front of chamber door, following 40 min. venting	19 19	11.0 7.6
30 ft. from chamber, following 40 min venting	20 18	0.2 0.2
50 ft. from chamber, following 40 min. venting	18	0.2
In front of chamber door, during opening	10 10	6.9 0.1
30 ft. from chamber, during door opening	20	0.5
50 ft. from chamber, during door opening	19	0.1

TABLE V

Facility #3, Stanislaus County, September 28, 1982

Sample Source	Sampling Time (Minutes)	Methyl Bromide Detected (ppm)
In front of chamber door, during fumigation	15	0.1
In front of chamber door, during opening	10	0.2
	15	8.3
	12	3.9
Fumigator personal sample, during injection	19	0.3
Employee personal sample, 300 ft. from chamber	19	0.3
	18	0.4

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